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PRELIMINARY OBSERVATIONS ON THE CHANGING ROLES OF MALARIA VECTORS IN SOUTHERN BELIZE[1]

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ABSTRACT. A survey for larval and adult *Anopheles* mosquitoes was conducted in Toledo District of southern Belize during August–September 1992. We surveyed for larvae in 145 habitats and conducted paired indoor–outdoor collections of adult mosquitoes landing on humans at 6 houses. In 1940–41, Kumm and Ram reported *Anopheles darlingi* females to be the most common *Anopheles* mosquitoes inside houses and reported no specimens of *Anopheles vestitipennis* in southern Belize. In our 1992 survey we found no *An. darlingi* mosquitoes either as adults or larvae. More *An. vestitipennis* females were captured indoors than outdoors, whereas most *Anopheles albimanus* and *Anopheles apicimacula* females were captured outdoors. All 3 species were represented occasionally in 145 collections of larvae from diverse habitats. *Anopheles vestitipennis* now appears to be a potentially important vector of malaria during the wet season in Toledo District.

The presence of *Anopheles darlingi* Root in Belize was first reported by Komp in 1940. The identity of Komp's original *An. darlingi* specimens was recently verified by Linthicum (1988). In 1941, Kumm and Ram documented the occurrence of house-frequenting populations of *An. darlingi* in the Toledo and Stann Creek districts of Belize (Fig. 1). Kumm and Ram relied heavily on searches of houses for resting mosquitoes as their primary survey method. *Anopheles darlingi* was found in 3 of 7 localities surveyed in Toledo District and in 5 of 7 localities in Stann Creek District. The larvae of *An. darlingi* were also collected in both districts. *Anopheles vestitipennis* Dyar and Knab was not collected as adults or larvae in Toledo District, but was collected as adults at 3 of 7 localities and as larvae in Stann Creek District. *Anopheles albimanus* Wiedemann was the most widely distributed species, being present at 9 of 14 localities from both districts. Larvae of *An. albimanus* were also collected in both Toledo and Stann Creek districts. Malaria sporozoites were found in the salivary glands of *An. darlingi* and *An. vestitipennis*, but not *An. albimanus*. *Anopheles darlingi* was the dominant indoor anopheline, representing more than 70% of the anophelines caught indoors in rural areas.

The Kumm and Ram survey was conducted more than 50 years ago, prior to the use of DDT in the malaria control program in Belize. Since their survey, no comparable data have been published for the Toledo District. Thirty years later, Bertram (1971) did not encounter a single specimen of *An. darlingi* in an extensive survey of adult mosquitoes in northern Belize, including areas of Stann Creek District. Although few collections have been conducted in Belize, the last documented appearance of *An. darlingi* in Belize was at Serra de Aqua in June 1946 (Linthicum 1988).

We initiated a malaria vector research program in Belize in 1990 and conducted extensive larval surveys in northern Belize, including Corozal, Orange Walk, Belize City, Cayo, and Stann Creek districts. No *An. darlingi* or *An. vestitipennis* larvae were collected in those surveys (Rejmankova et al. 1993). In a recent wet season survey in Toledo District we included nighttime, paired indoor–outdoor landing collections from humans to increase the likelihood of detecting the presence of *An. darlingi* and *An. vestitipennis*. These collections were performed by capturing mosquitoes as they landed on the exposed legs and feet of 2–4 collectors. Paired indoor–outdoor collections, using 1–2 collectors per indoor or outdoor site, were conducted one evening at each of 6 localities from 1830 to 1915 h. Based on past experience (Roberts et al. 1987), we expected the sunset interval to be a period of peak *An. darlingi* host-seeking activity. After completing the survey we learned that Rivera-Nunez (1990[6]) recently reported a sunset peak (1800–

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[6] Rivera-Nunez, L. A. 1990. Algunos aspectos de comportamiento de *Anopheles darlingi* (Diptera: Culicidae) de la Ceiba, Atlantida, Honduras. Thesis. Maestria en Entomologia. Universidad de Panama, Panama City, Panama.

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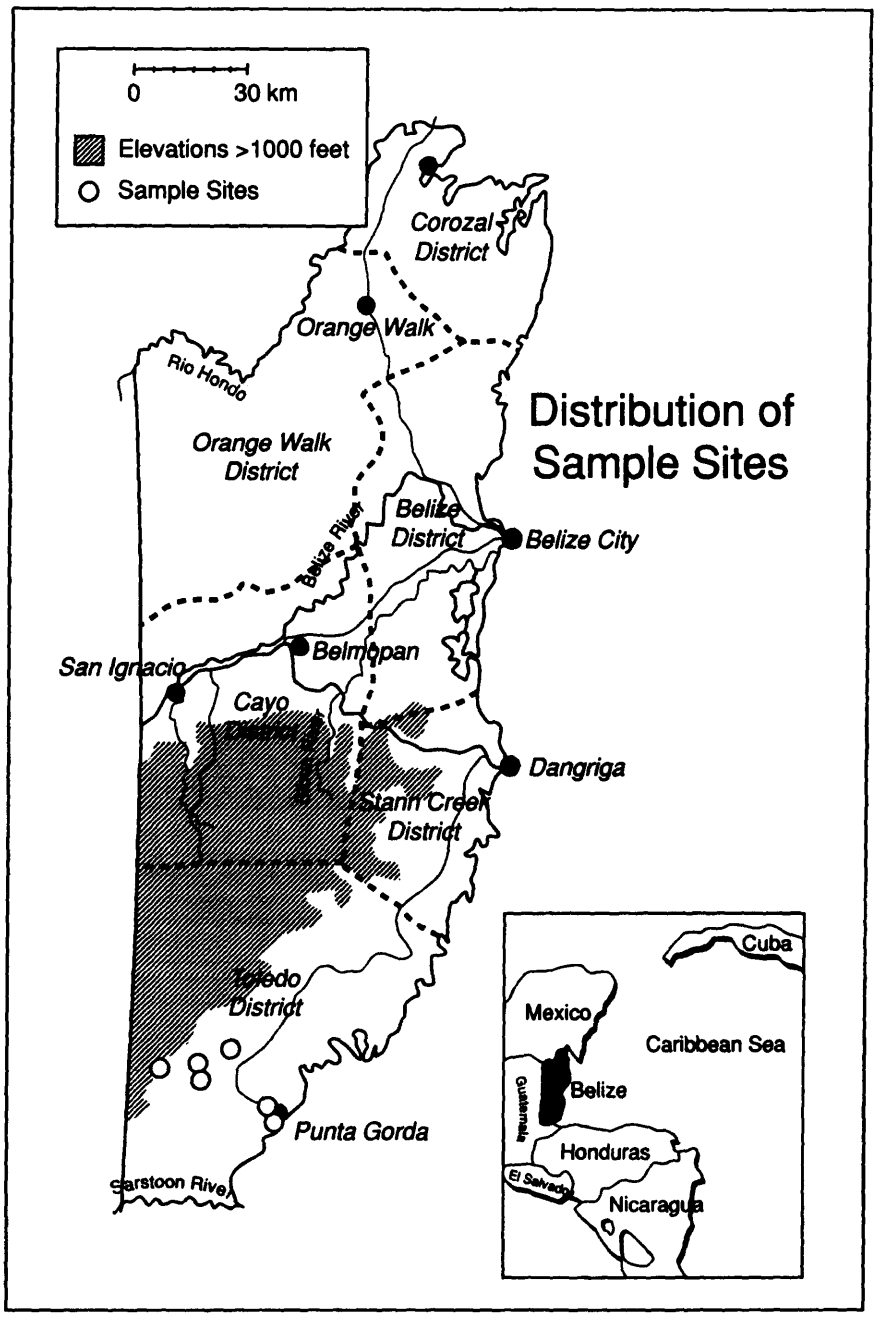

Fig. 1. Map of Belize depicting the distribution of collection sites in Toledo district, near Punta Gorda, Belize.

1900 h) in activity for *An. darlingi* populations in Honduras. Although we employed uniform collecting methods, we could not control for the numbers of children and adults who gathered around the collectors at both indoor and outdoor collecting sites. Although the collection data were not strongly quantitative, observations on relative composition of indoor versus outdoor collections seemed valid. Most houses had dirt floors and were constructed with loose-fitting wood or

Table 1. Numbers of anophelines collected from humans in paired indoor–outdoor landing collections in the Punta Gorda area of southern Belize during August and September 1992.

	Anopheles albimanus	*Anopheles vestitipennis*	*Anopheles apicimacula*
Collection site	Inside/outside	Inside/outside	Inside/outside
Jacinto Landing	2/3	27/4	0/0
Santa Helena	2/1	0/0	0/2
Crique Mafredi[1]	5/2	39/7	7/29
Crique Trosa[1]	0/2	9/0	9/33
Punta Gorda	0/2	2/1	0/0
Big Fall	1/25	0/1	0/0
Totals	10/35	77/13	16/64

[1] Houses not sprayed with DDT.

palm slats and a thatch roof. Two houses in Punta Gorda and Big Fall were solid and tightly enclosed.

Collections were performed at 6 sites in the area of Punta Gorda (Toledo District) in southern Belize (Fig. 1). Although collections were conducted in the same general areas surveyed by Kumm and Ram (1941), due to demographic changes during the intervening 51 years, their specific sites were no longer in existence. In addition to the nighttime landing collections, we conducted larval collections at 145 sites in Toledo District. Specimens from all categories of collections have been deposited in the mosquito collection of the Walter Reed Biosystematics Unit at the Smithsonian Institution.

No larvae or adults of *An. darlingi* were encountered during our survey. The dominant species collected biting indoors was *An. vestitipennis* (Table 1). Both *an. albimanus* and *An. vestitipennis* were widely distributed, being present at 6 and 5 sites, respectively. Overall, larger proportions of *An. albimanus* (78%) and *Anopheles apicimacula* Dyar and Knab (80%) were collected outdoors than indoors. In contrast, 86% of all *An. vestitipennis* females were collected indoors. All 3 *Anopheles* species collected in landing captures were also represented in the larval collections.

Collection data presented herein indicate that *An. darlingi* is either restricted to specific localities that we did not sample, very uncommon, or possibly absent in Toledo District. In April and May 1993, we finally encountered populations of *An. darlingi* adults in riverine environments of Stann Creek District. As a consequence, we think *An. darlingi* is probably present in Toledo District, but is limited to specific riverine localities.

Although *An. vestitipennis* was not encountered in Toledo District during 1940, it was numerically dominant inside houses during our survey. This species seemed undeterred by DDT residues because large numbers of *An. vestitipennis* females were captured inside both DDT-sprayed and unsprayed houses. Another intriguing aspect of this species' behavior relates to our capturing many more inside houses than were captured outdoors. The openness of many native houses in rural southern Belize probably facilitates this indoor-feeding behavior. In contrast, the host-seeking females of *An. apicimacula,* like *An. albimanus,* were much more abundant outdoors. Exophagic behavior of the latter 2 species should serve to diminish their overall vectorial capacity.

Recent studies by Loyola et al. (1991) and Padilla et al. (1992) have incriminated *An. vestitipennis* as a vector of human malaria in the Marqués de Comillas region of southern Mexico and in 2 communities in northern Guatemala, respectively. The latter studies, in combination with recent data compiled by Padilla in Guatemala (personal communication), show *An. vestitipennis* to be endophagic, but not as strongly endophagic as indicated by our data from Toledo District. Consequently, a greater sampling effort covering the entire nighttime interval will possibly show a greater relative tendency of *An. vestitipennis* females to feed outdoors in Toledo District.

The presence and abundance of malaria vectors are under the control of dynamic environmental variables, as well as human interventions. This report emphasizes the need to continuously study the changing roles of malaria vectors in different geographical areas. Based on the published literature, we can expect *An. darlingi*-transmitted malaria to respond favorably to a DDT house-spray program (Rozendaal et al. 1989, Roberts and Alecrim 1991). However, these expectations must be reevaluated if *An. vestitipennis* has become the primary vector of malaria in nonriverine areas of Toledo District.

Hopefully, this report will be the precursor of more definitive studies on vector responses to DDT-sprayed houses and on vectorial roles in different ecological zones of Belize.

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REFERENCES CITED

Bertram, D. S. 1971. Mosquitoes of British Honduras, with some comments on malaria, and on arbovirus antibodies in man and equines. Trans. R. Soc. Trop. Med. Hyg. 65:742–762.

Komp. W. H. W. 1940. The occurrence of *Anopheles darlingi* Root in British Honduras and Guatemala. Science 91:522–523.

Kumm, H. W. and L. M. Ram. 1941. Observations on the *Anopheles* of British Honduras. Am. J. Trop. Med. Hyg. 21:559–566.

Linthicum, K. J. 1988. A revision of the Argyritarsis section of the subgenus *Nyssorhynchus* of *Anopheles* (Diptera: Culicidae). Mosq. Syst. 20:98–271.

Loyola, E. G., J. I. Arredondo, M. H. Rodríguez, D. N. Brown and M. A. Vaca-Marin. 1991. *Anopheles vestitipennis*, the probable vector of *Plasmodium vivax* in the Lacandon forest of Chiapas, México. Trans. R. Soc. Trop. Med. Hyg. 85:171–174.

Padilla, N., P. Molina, J. Juarez, D. Brown and C. Cordon-Rosales. 1992. Potential malaria vectors in northern Guatemala (Vectores potenciales de malaria in la región norte de Guatemala). J. Am. Mosq. Control Assoc. 8:307–308.

Rejmankova, E., D. R. Roberts, R. E. Harbach, J. Pecor, E. L. Peyton, S. Manguin, R. Krieg, J. Polanco and L. Legters. 1993. Environmental and regional determinants of *Anopheles* larval distribution in northern Belize. J. Environ. Entomol. (in press).

Roberts, D. R. and W. D. Alecrim. 1991. Behavioral response of *Anopheles darlingi* to DDT-sprayed house walls in Amazonia. PAHO Bull. 25:210–217.

Roberts, D. R., W. D. Alecrim, A. M. Tavares and M. G. Radke. 1987. The house-frequenting, host-seeking and resting behavior of *Anopheles darlingi* in southeastern Amazonas, Brazil. J. Am. Mosq. Control Assoc. 3:433–441.

Rozendaal, J. A., J. P. M. Van Hoof, J. Voorham and B. F. J. Oostburg. 1989. Behavioral responses of *Anopheles darlingi* in Suriname to DDT residues on house walls. J. Am. Mosq. Control Assoc. 5:339–350.